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Regan

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(54) **NO-BACK CHECK DEVICE**

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B64C 13/34	(2006.01)
F16D 66/00	(2006.01)

(52) **U.S. Cl.**

CPC ***F16D 41/00*** (2013.01); ***B64C 13/34*** (2013.01); ***F16D 65/0043*** (2013.01); *F16D 2066/006* (2013.01)

(58) **Field of Classification Search**

CPC B64C 13/34

See application file for complete search history.

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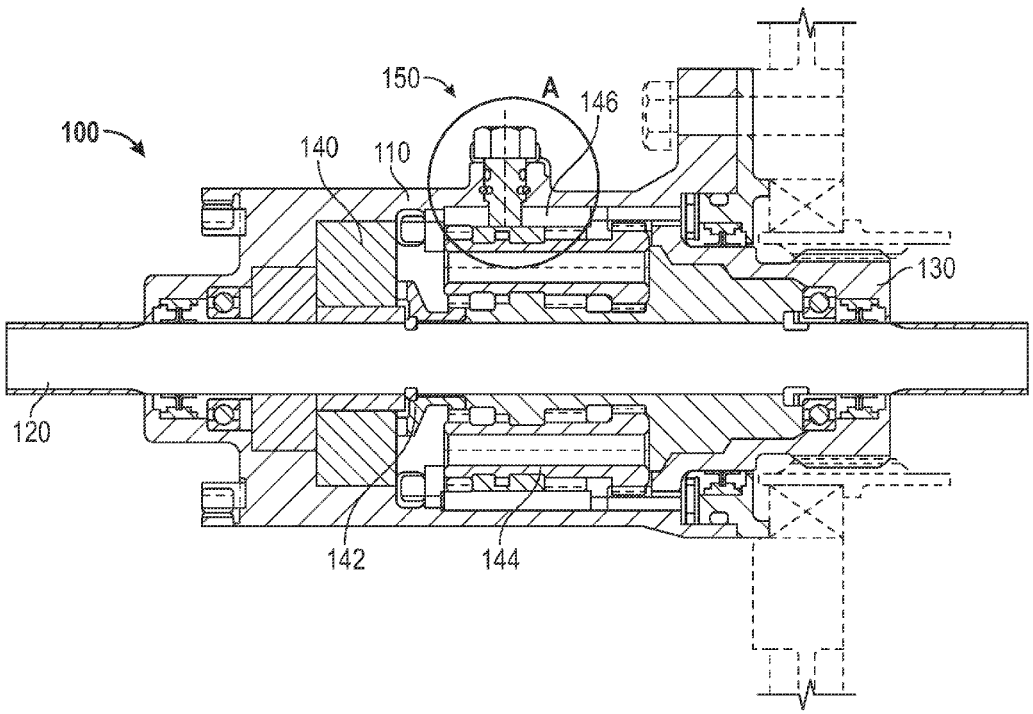
(57) **ABSTRACT**

A device and method for determining whether a no-back device is functioning properly includes a no-back device coupling an input shaft and an output shaft. A no-back output gear is coupled to the output shaft, and a reaction gear is operably coupled to the no-back output gear. A check device includes a rotatable drive feature having a first end accessible for rotation and a second end engaged with the reaction gear. The functionality of the no-back device is evaluated by applying a rotational torque to the drive feature.

15 Claims, 3 Drawing Sheets



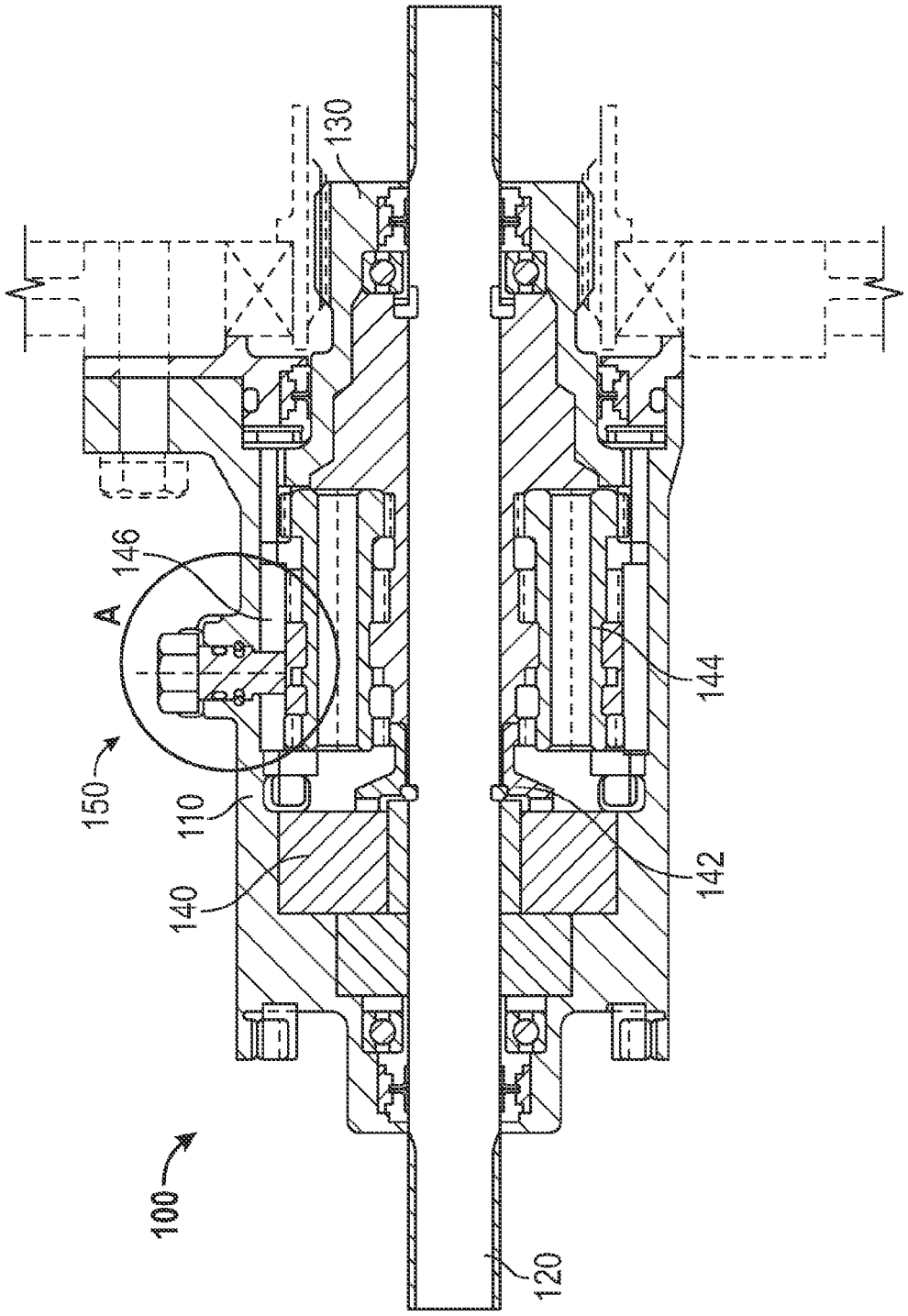


FIG. 1

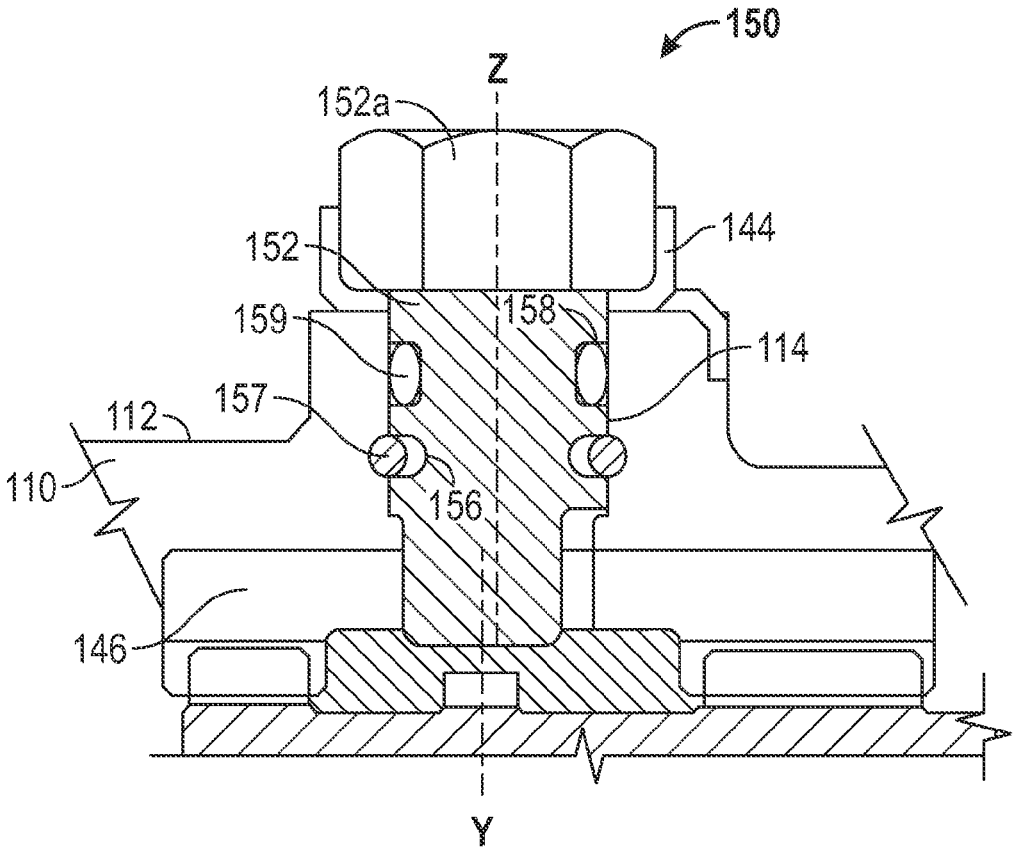


FIG. 2A

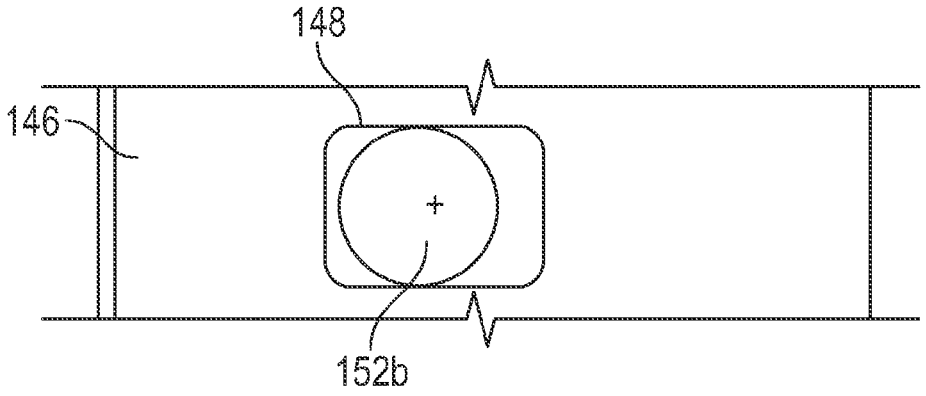


FIG. 2B

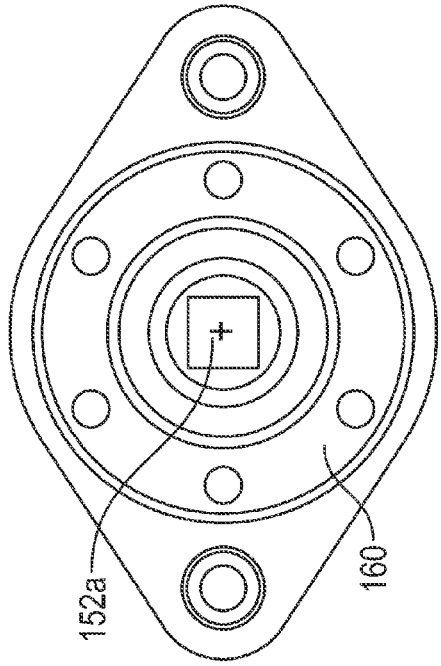


FIG. 3B

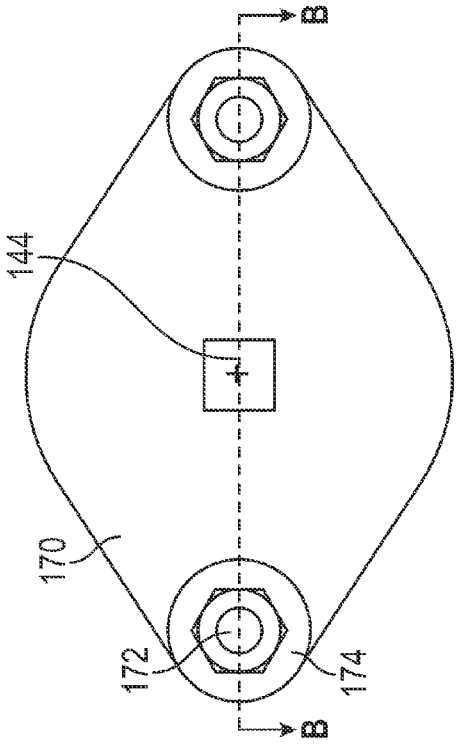


FIG. 3A

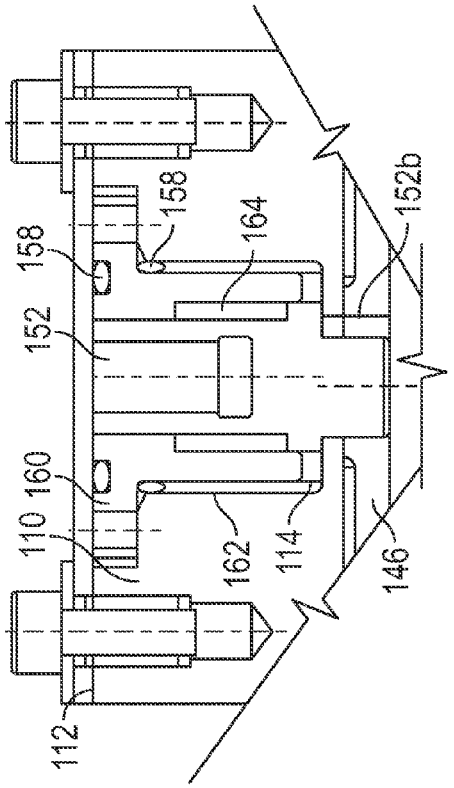


FIG. 3C

NO-BACK CHECK DEVICE

BACKGROUND OF THE INVENTION

This invention relates to an actuation system and more particularly to an actuation system having a no-back device.

Modern aircrafts are commonly equipped with actuators containing no-back devices. These actuators are subjected to aerodynamic loads resulting from the distribution of loads in the aircraft, from the trajectory of the aircraft, and from the flight conditions. No-back devices are employed in actuators of mechanical drive systems where it is necessary to prevent an aerodynamic load, from back driving the system in the event of a structural failure or disconnect of the input shaft to an actuator. A typical no-back device has a releasable brake associated with an output shaft as well as an input shaft connected to a prime mover. A coupling between the input shaft and output shafts operates in response to the transmission of torque from the output shaft to the input shaft to prevent movement of the output shaft, and assure that the element associated with the output shaft will remain in the position in which it was originally placed by operation of the prime mover.

The functionality of the no-back device is critical in instances where it is required. A failure of a no-back device is potentially dangerous since a shaft could be driven by the aerodynamic forces acting on the element to be actuated. The element would then not be held in the desired position, and could flutter rendering the aircraft unstable. It is therefore desirable to develop a system that easily and efficiently allows a mechanic to verify that the no-back device in an actuator is functioning properly.

BRIEF DESCRIPTION OF THE INVENTION

According to one embodiment of the invention, a device for determining the functionality of a no-back device includes a no-back device coupling an input shaft and an output shaft. A no-back output gear is coupled to the output shaft. A reaction gear is operably coupled to the no-back output gear. A check device includes a rotatable drive feature having a first end accessible for rotation and a second end engaged with the reaction gear. The functionality of the no-back device may be evaluated by applying a rotational torque to the drive feature.

According to another embodiment of the invention, a device for determining the functionality of a no-back device in an actuator includes an actuator housing. Within the actuator housing is a no-back device coupling an input shaft and an output shaft. A no-back output gear is coupled to the output shaft adjacent an external surface of the no-back device. A reaction gear is operably coupled to the no-back output gear. The device further includes a check device having a rotatable drive feature with a first end extending through and accessible from the actuator housing and a second end engaged with the reaction gear. The functionality of the no-back device may be determined by applying a rotational torque to the drive feature.

According to yet another embodiment of the invention, a method for verifying the functionality of a no-back device is provided including locking an output shaft against rotation and allowing an input shaft to freely rotate. The stop device is then removed from the check device such that the drive feature may freely rotate. The drive feature is rotated to a first position and the rotation of an input shaft is evaluated. The drive feature is then rotated to a second position where the rotation of an input shaft is again evaluated.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a cross-sectional view of an actuator assembly;

FIG. **2**A is a detailed view of an embodiment of the invention as shown in circled area A in FIG. **1**;

FIG. **2**B is a bottom view of the FIG. **2**A;

FIG. **3**A is an top view of an alternate embodiment of the invention;

FIG. **3**B is a top view of FIG. **3**A with the cover removed; and

FIG. **3**C is a cross-sectional side view of FIG. **3**A taken across line B-B.

The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. **1**, an actuator assembly **100** usable in an aircraft is shown. The actuator assembly **100** includes an actuator housing **110**. An input shaft **120** is coupled to an output shaft **130** in a coaxial relation. Providing a connection between the input shaft **120** and output shaft **130** is a no-back device **140**. The output shaft **130** is locked by the no-back device **140** to prevent external loads from back driving the actuator assembly **100** into a potentially hazardous position in the event of a structural failure or disconnect of the input shaft to the actuator. The input shaft **120** may be driven either clockwise or counterclockwise. When the no-back device **140** is functioning properly and the input shaft **120** is stationary, the output shaft **130** is automatically locked against back driving, in either the clockwise or counterclockwise directions. No-back devices are known and a person having ordinary skill in the art would be able to select a no-back device appropriate for the particular application.

Positioned adjacent an external surface of the no-back device **140** is a no-back output gear **142**, such as a sun gear for example. A reaction gear **146** is coupled with the no-back output gear **142**. In one embodiment, the reaction gear **146** is directly coupled to the no-back output gear **142**. In an alternate embodiment, the reaction gear **146** is indirectly coupled to the no-back output gear **142** through a planetary gear assembly **144** having at least one additional gear. A check device **150** engages the reaction gear **146**, such that rotation of the check device **150** while the output shaft **130** is locked determines whether the no-back device **140** is functioning properly.

In a first embodiment of the invention, shown in FIGS. **2**A and **2**B, the check device **150** includes a drive feature **152**, extending through a hole **114** in the actuator housing **110**, allowing rotation between a first position and a second position. A first end **152***a* of the drive feature **152** is accessible from outside the actuator by a person, such as a mechanic for example. The first end **152***a* is positioned adjacent the outer surface **112** of the actuator housing **110**. In one embodiment, this first end **152***a* of the drive feature **152** includes a head, such as a hex head, that allows a mechanic to easily apply a rotational torque to the drive feature **152**. A stop device **144**,

such as a lock washer for example, is disposed between the first end **152***a* of the drive feature **152** and the actuator housing **110** to prevent unwanted rotation of the drive feature **152** when a mechanic is not checking the functionality of the no-back device. The body of the drive feature **152** between the first end **152***a* and the second end **152***b* includes a first groove **156**. An axial retention feature **157**, such as a C-clip for example, connects to drive feature **152** and is positioned within the first groove **156** to prevent the drive feature **152** from sliding vertically relative to the actuator housing **110**. Disposed along the body of the drive feature **152** between the first groove **156** and the first end **152***a* is a circumferential second groove **158**. A seal **159** fits between the second groove **158** and the actuator housing **110** to prevent moisture from entering the actuator assembly **100**.

The second end **152***b* of the drive feature **152** includes an eccentric feature that extends into a slot **148** in the reaction gear **146**. In one embodiment, the drive feature **152** is an eccentric pin, wherein the central axis Z of the first end **152***a* of the pin is offset from the central axis Y of the second end **152***b* of the pin. When a rotational force or torque is applied to the first end **152***a* of the drive feature **152**, the eccentric feature of the second end **152***b* moves with respect to the slot **148**. This movement of the second end **152***b* creates a rotation of the reaction gear **146** which in turn causes a magnified rotation of the no-back output gear **142**.

In an alternate embodiment of the check device **150**, shown in FIGS. **3**A-**3**C, a threaded insert **160** is threadably engaged with hole **114** of the actuator housing **110**. The threaded insert **160** includes a flange attached to a body having a plurality of threads on an external surface **162** of the threaded insert **160**. The threaded insert **160** extends substantially from the reaction gear **146** to the actuator housing **110** such that when the threaded insert **160** is seated in position, the top surface of the flange is substantially flush with the outer surface **112** of the actuator housing **110**. Disposed within the threaded insert **160** is a drive feature **152** having a first end **152***a* accessible from the actuator housing **110** and a second end **152***b* extending into a slot **148** of reaction gear **146**. Coupled to the drive feature between the first end **152***a* and the second end **152***b* is a bearing **164** to minimize the drag of the drive feature **152** as it rotates within the threaded insert **160**. A seal **158** is located between the threaded insert **160** and the actuator housing **110**. An additional seal exists between the threaded insert **160** and a cover plate **170** of the check device **150** to prevent moisture from entering the actuator assembly **100**.

A cover plate **170** having at least one fastener **172** attaches to the outer surface **112** of the actuator housing **110**. Positioned between each fastener **172** and the housing **110** may be a washer **174**. Removal of the cover plate **170** from engagement with the actuator housing **110** exposes the first end **152***a* of the drive feature **152**. A stop device **144** is incorporated into the cover plate **170**. The surface of the cover plate **170** facing the drive feature **152** includes a protrusion **144** having a shape complementary to the first end **152***a* of the drive feature **152**. In one embodiment, the first end **152***a* of the drive feature **152** is square. When the cover plate **170** is attached to the actuator housing **110**, the first end **152***a* of the drive feature **152** aligns with the inner edge of the protrusion **144** such that the first end **152***a* is confined within the protrusion **144** and is thereby prevented from freely rotating.

To check the functionality of the no-back device **140**, an aircraft mechanic first adjusts the actuator assembly **100** such that the output shaft **130** is locked and the input shaft **120** is free to rotate. The mechanic then removes the stop device **144** of the check device **150** so that the drive feature **152** can rotate. In the illustrated embodiments, removal of the stop device **144** includes removing either a lock washer or a cover plate from engagement with the drive feature **152**. The first end **152***a* of the drive feature **152** is then rotated clockwise ninety degrees from a normal to a first "Check-Clockwise" position. After the mechanic performs a check of the no-back device **140** with the drive feature **152** in the first position, the first end **152***a* of the drive feature **152** is rotated back to the normal position. The mechanic then rotates the drive feature **152** ninety degrees in counterclockwise to a second "Check-Counterclockwise" position where the mechanic again evaluates the functionality of the no-back device **140**. After the functionality of the no-back device **140** has been verified in both the clockwise and counterclockwise positions, the drive feature **152** is returned to the normal position, and the stop device **144** is re-engaged. The rotation of the drive feature **152** to each of the first and second positions results in a specific amount of rotation of the reaction gear **146**. Dependent on the gear ratio between the reaction gear **146** and the no-back output gear **142**, the generally small amount of rotation of the reaction gear **146** will result in a substantially magnified angular rotation of the no-back output gear **142**.

This rotation of the no-back output gear **142** is used to verify the functionality of the no-back device **140**. If the no-back device **140** has no lost motion, braking of the no-back output gear should result if the no-back device **140** is functioning correctly. If the no-back device **140** includes lost motion, the no-back output gear **142** must be sufficiently rotated beyond the lost motion threshold for braking of the no-back output gear **142** to result, thereby demonstrating the proper functioning of the no-back device **140**. If, however, the no-back device **140** is not functioning properly, regardless of whether it includes lost motion, rotation of the no-back output gear **142** will result in visible rotation of input shaft **120**, and service is required.

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

The invention claimed is:

1. A device for determining the functionality of a no-back device comprising:

the no-back device coupling an input shaft and an output shaft;

a no-back output gear coupled to the output shaft;

a reaction gear operably coupled to the no-back output gear; and

a check device including a rotatable drive feature having a first end accessible for rotation and a second end engaged with the reaction gear such that the functionality of the no-back device is determined by applying a rotational torque to the drive feature.

2. The device according to claim **1**, wherein the reaction gear is indirectly coupled to the no-back output gear.

3. The device according to claim **1**, wherein the reaction gear is directly coupled to the no-back output gear.

4. The device according to claim **1**, further comprising a stop device for preventing unwanted rotation of the drive feature.

5. The device according to claim 1, wherein the second end of the drive feature has an eccentric feature.

6. The device according to claim 5, wherein the drive feature is an eccentric pin.

7. The device according to claim 1, wherein an axial retention feature prevents the drive feature from moving vertically.

8. A device for determining the functionality of a no-back device in an actuator comprising:

an actuator housing;

the no-back device disposed within the actuator housing, the no-back device coupling an input shaft and an output shaft;

a no-back output gear coupled to the output shaft, the no-back output gear being positioned adjacent an external surface of the no-back device;

a reaction gear operably coupled to the no-back output gear; and

a check device including a rotatable drive feature having a first end extending through and accessible from the actuator housing and a second end engaged with the reaction gear such that the functionality of the no-back deviceis determined by applying a rotational torque to the drive feature.

9. The device according to claim 8, wherein the reaction gear is indirectly coupled to the no-back output gear.

10. The device according to claim 8, further comprising a stop device for preventing unwanted rotation of the drive feature.

11. The device according to claim 10, wherein the stop device is a lock washer.

12. The device according to claim 10, wherein the stop device is a protrusion on a cover plate that aligns with the first end of the drive feature when attached to the actuator housing.

13. The device according to claim 8, wherein the second end of the drive feature includes an eccentric feature.

14. The device according to claim 13, wherein the drive feature is an eccentric pin.

15. The device according to claim 8, wherein the check device includes at least one seal for preventing moisture from entering the actuator.

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